COST AND PERFORMANCE REPORT

Pump and Treat of Contaminated Groundwater at the
LaSalle Electrical Superfund Site
LaSalle, Illinois

September 1998

Prepared by:

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information:

LaSalle Electrical Superfund Site
LaSalle, Illinois

CERCLIS #: SCD980711394

ROD Date: March 30, 1988

Treatment Application:

Type of Action: Remedial

Period of operation: 12/92 - Ongoing
(Data collected through 1997)

Quantity of material treated during application: 23 million gallons of groundwater

Background

Historical Activity that Generated Contamination at the Site: Electrical equipment manufacturing

Corresponding SIC Code: 3612 (power, distribution, and specialty transformers)

Waste Management Practice That Contributed to Contamination: Spills from capacitor cleaning and spreading polychlorinated biphenyls (PCB)-laden waste oils as a dust suppressant

Location: LaSalle, Illinois

Facility Operations: [4,7]

- LaSalle Electrical Utilities (LEU) operated this 10-acre site as a manufacturing facility for electrical equipment from 1940 to 1978. PCB and chlorinated solvents were used in the manufacturing processes during this time.
- Site contamination resulted from operations, spills of dielectric fluids from capacitor cleaning, and PCB-laden waste oils that were applied as a dust suppressant to the ground surface.
- As a result of complaints, government agencies issued several orders in 1975 against LEU for its manufacturing and waste handling practices.
- In 1980 and 1981, Illinois EPA (IEPA) performed sampling at the site which confirmed the presence of PCB and volatile organic compound (VOC) contamination in soils and groundwater.
- In 1981, EPA ordered LEU to cease operations because of its waste management practices and existing health threats.
- The site was placed on the National Priorities List (NPL) in December 1982.
- Between 1982 and 1986, several emergency removal actions occurred at the site to package, stage, or cap highly contaminated soil.
- A remedial investigation (RI) and feasibility study were completed between 1983 and 1985.
- In March 1986, after review of the draft RI report, the U.S. EPA elected to split the site into two separate projects. The 1985 RI had adequately characterized the soil contamination in the area. However, it had failed to sufficiently determine the extent of groundwater contamination emanating from the LEU property. A second RI addressing groundwater conditions was completed in 1988.
- Under a separate Record of Decision (ROD), (issued in September 1986), highly contaminated soils were excavated and incinerated. The incinerated soils were replaced and regraded across the site.

Regulatory Context:

- A ROD was signed for groundwater remediation on March 30, 1988.

SITE INFORMATION (CONT.)

Background (Cont.)

- Site activities were conducted under provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, §121, and the National Contingency Plan (NCP), 40 CFR 300.

Groundwater Remedy Selection:
The selected remedy for groundwater at this site was extraction and treatment of groundwater via air stripping and carbon adsorption.

Site Logistics/Contacts

Site Lead: State

Oversight: EPA

State Contact:
Rich Lange*
Illinois EPA (IEPA)
2200 Churchill Road
P.O. Box 19276
Springfield, Illinois 62794-9276
(815) 223-1126

Treatment System Vendor:
Ecology & Environment, Inc.
ThermoCor Kimmons

*Indicates primary contact

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: Groundwater

Contaminant Characterization [6, 7]

Primary Contaminant Groups: PCBs and halogenated VOCs

- The primary contaminants of concern at this site are the PCBs: Arochlor-1242, -1248, and -1254; and VOCs: tetrachloroethylene (PCE), trichloroethylene (TCE), *trans*-1,2-dichloroethylene (*trans*-1,2-DCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), and vinyl chloride (VC).
- Maximum groundwater contaminant concentrations detected by EPA during initial investigations in 1980-1981 were PCB (760,000 µg/L), TCE (13,341 µg/L), trans-1,2-DCE (7,152 µg/L), 1,1,1-TCA (3,123 µg/L), and VC (500 µg/L).
- The plume of groundwater contaminants initially detected in 1980 was estimated by the IEPA to cover over 700,000 square feet [7].
- Figure 1 illustrates PCB concentration contours at the LaSalle Electrical site in 1982. The plume of VOCs is not shown in Figure 1; however, the VOC plume is approximately the same size and in the same location.

MATRIX DESCRIPTION (CONT.)

Contaminant Characterization (Cont.)

- Concentrations of PCBs in soils up to 17,000 ppm were detected at several locations on site. These soils were excavated and incinerated in 1991 and 1992.
- Site engineers observed a dense non-aqueous phase liquid (DNAPL) in the bottom three to five feet of a 10 foot well casing up to 300,000 µg/L PCB. The amount of DNAPL present in the subsurface was unknown; however, significant quantities of oily liquids were removed with excavated soils.

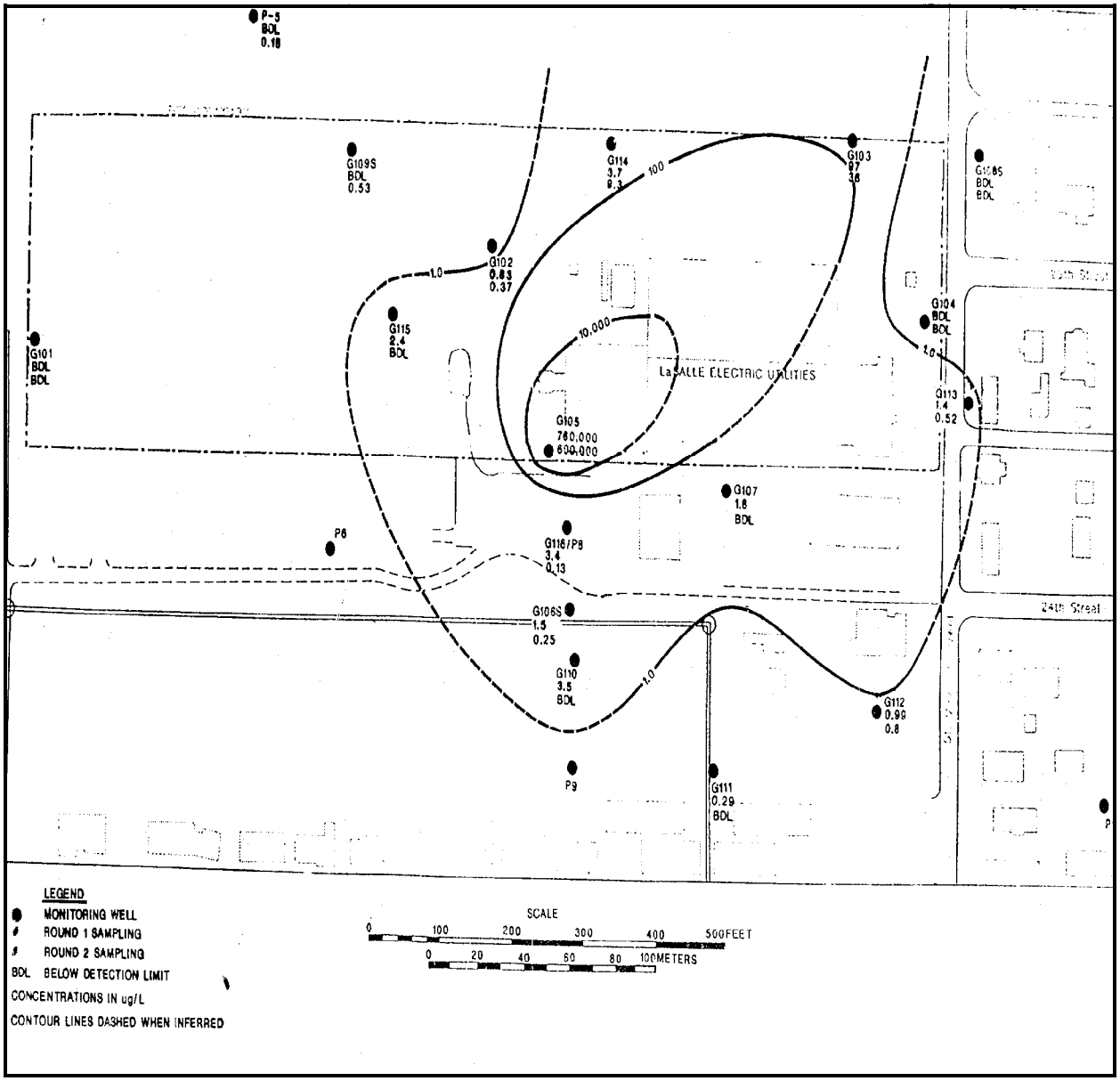

Figure 1. Initial PCB Concentration Contour Map (Best Copy Available) (1982) [6]

MATRIX DESCRIPTION (CONT.)

Matrix Characteristics Affecting Treatment Costs or Performance [6]

Hydrogeology:

Three primary units have been identified within the upper 100 feet of the soils at this site. Two of these units function as aquifers (Units 1 and 3), and the third functions as an aquitard (Unit 2). Upward vertical gradients are observed across the site which limit the downward migration of contaminants into the lower water bearing unit (Unit 3). The water table is encountered at three to five feet below ground surface. Contaminants are primarily found in the shallow aquifer (Unit 1) and are migrating in a southeast direction with the natural groundwater flow.

Unit 1	Malden Till	Interbedded unit of sand, silt, and clay, which is an unconfined water-bearing unit.
Unit 2	Tiskilwa Till	Silty clay and clay with occasional silt and sand lenses, which acts as an aquitard. This unit is discontinuous across the site.
Unit 3	Bond Formation	Bedrock unit composed of clay, shale, and coal seams at depth.

Table 1 presents the technical aquifer characteristics. This information comes from the Phase II Remedial Investigation performed in 1988.

Table 1. Technical Aquifer Information [6]

Unit Name	Thickness (ft)	Conductivity (ft/day)	Average Velocity (ft/day)	Flow Direction
Malden Till	15-25	0.22 (K_h)	.016	Southeast
Tiskilwa Till	10-12	0.000005 (K_v)	NC	NC
Bond Formation	>60	0.0005 (K_h)	NC	Southeast

K_h - Horizontal conductivity, K_v - Vertical conductivity, NC - Not characterized

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Pump and treat with air stripping and carbon adsorption.

Supplemental Treatment Technology

Vapor-phase carbon adsorption, oil/water separation.

System Description and Operation

System Description [5,6]

- The groundwater collection system is a passive design that uses three infiltration trenches instead of wells. It was designed to capture the on-site groundwater directly beneath the original plant site, and extends 200 feet south of the original plant site. The one main east-west collection trench and the north-south collection trenches form an H-pattern. The north-south collection trenches drain to the east-west trench, which in turn flows to a wet well. Collected groundwater is pumped from the wet well to the groundwater treatment unit. The average extraction rate is 10-15 gpm. Figure 2 shows the groundwater collection and monitoring system at the LEU site.

TREATMENT SYSTEM DESCRIPTION (CONT.)

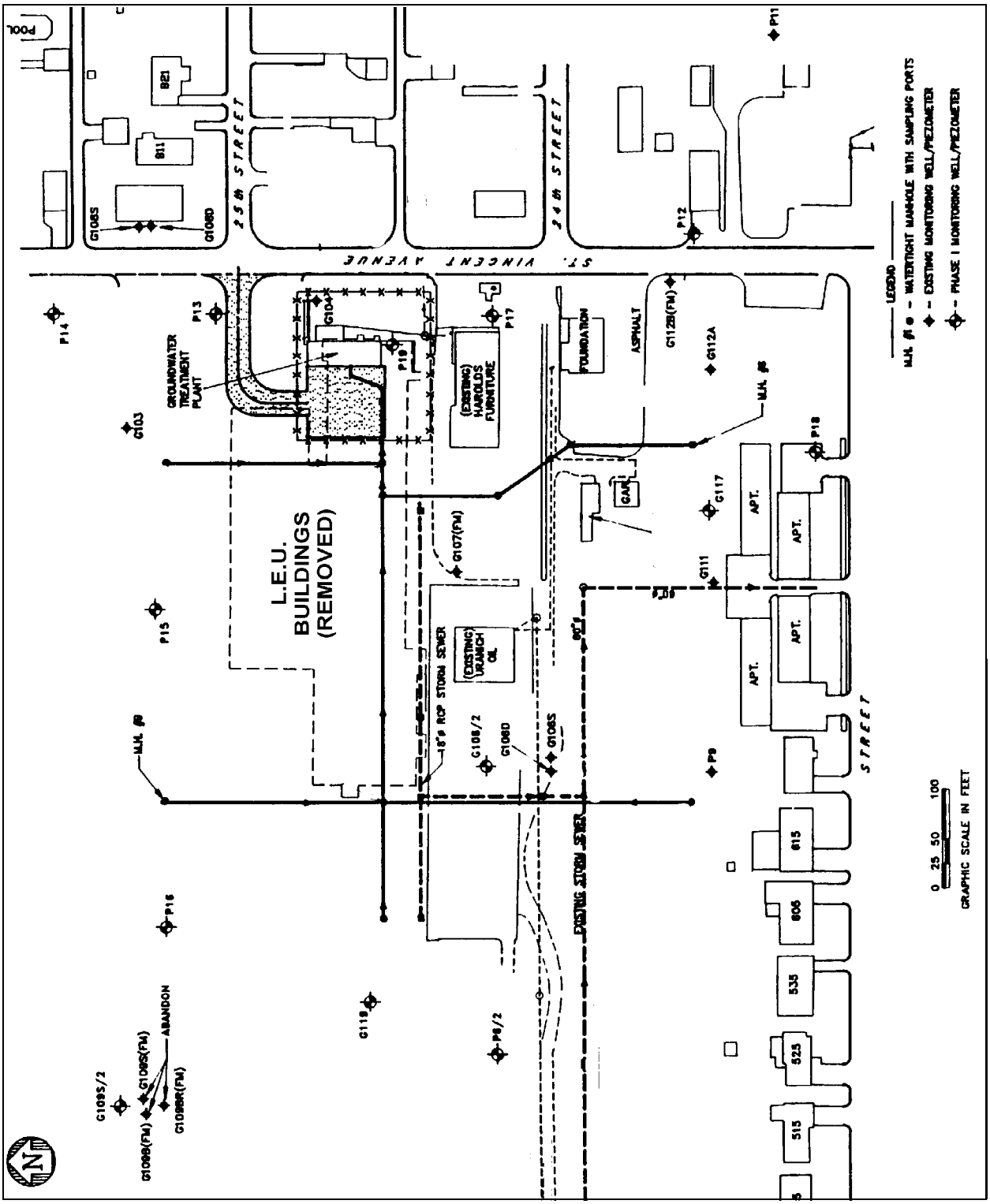

Figure 2. Site Diagram [2]

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

- The collection system consists of trenches with six-inch perforated polyvinyl chloride (PVC) pipe installed horizontally approximately 17 to 25 feet deep. The perforated pipe was installed in a 4-foot deep by 4-foot wide gravel bed. The gravel bed is surrounded by filter fabric to retard infiltration of fines. The on-site trenches were backfilled with incinerated soil to within one foot of final grade. The backfilled soils were then capped with six inches of clay and six inches of topsoil to limit infiltration. Parts of the collection system which extended off-site were backfilled to within five feet of final grade and capped with clean fill and one foot of top soil.

- The groundwater treatment unit consists of an oil/water separator and twin air strippers for the chlorinated solvents. A vapor-phase carbon adsorption unit is used to treat gas vapors from the strippers. Two 10,000-pound liquid phase carbon adsorption systems are used to remove the suspended and dissolved PCBs. An acid injection system was added to the original design to control pH of the effluent.

- The air strippers are operated in series. Each is two feet in diameter and has 11 feet of packing material. The stripping columns are 23 feet tall. The design ratio of air to water is 50:1.

- Effluent from the treatment system is discharged to a local Publicly Owned Treatment Works (POTW) under an industrial pretreatment permit.

- The groundwater monitoring system includes monitoring wells for the deep aquifer and manhole sampling points in collection trenches for the shallow aquifer.

System Operation [5,7]
This report covers operation of the collection and treatment systems during construction and through September 1997.

- Quantity of groundwater pumped from aquifer in gallons:

Year	Volume Pumped (gal)
1992	3,015,000
1993	5,700,000
1994	2,620,000
1995	3,895,000
1996	4,800,000
1997 (9 months)	3,200,000

- The treatment unit was completed in April 1992 and began to operate by treating the groundwater and precipitation that accumulated in open excavations during construction activities.

- In December 1992, part of the collection system was installed. The remainder of the collection network was installed between March 1993 and June 1993. The collection system was installed in phases to minimize the number of open trenches at one time.

- Approximately eight million gallons were treated through the system between April 1992 and September 1993. The average extraction rate is approximately 18,000 gallons per day based on the volume of water treated to date.

- The full collection system went online in September 1993. The remedial system is operated in a batch mode. Groundwater is extracted for approximately 8-10 hours, then the aquifer is allowed to recover for 12-16 hours. The treatment system is designed for an optimum capacity of 20 gpm. It has been operating between 10-15 gpm to handle the volume of water extracted. According to the site contact, the treatment system has operated for approximately 15,530 hours and treated 14.6 million gallons since September 1993.

- The extraction system is operational five days a week 24 hours a day. An operator is on-site daily 4-8 hours.

- The pH of effluent is controlled to maintain compliance with the discharge permit. Caustic conditions also have caused a

TREATMENT SYSTEM DESCRIPTION (CONT.)

System Description and Operation (Cont.)

mineral deposit to build up in the first carbon unit. Control of pH levels has minimized this problem.

- The oil/water separator has been used primarily as a settling tank for entrained solids. No oil component has been noted in the influent stream during the operation of the system.
- Air stripping media have not been changed; however, the polypropylene media has required acid washing to remove deposits every two years.
- Since start-up in 1993, the site has been operational approximately 75% of the time. The system was shut down from July 1994 through January 1995 during a period of negotiation with the construction contractor over cost and scope of work for operations and maintenance [7].
- Spent carbon was changed once in 1993. Influent concentrations to the carbon units have generally been below detection limits since that time and have not exceeded the capacity of the carbon.

Operating Parameters Affecting Treatment Cost or Performance

The groundwater extraction rate is a major operating parameter affecting cost or performance for this technology. Table 2 presents the average extraction rate between 1993 and 1997 and the performance parameters required to restore the groundwater to primary drinking water standards.

Table 2: Performance Parameters

Parameter	Value	
Average Extraction Rate (1993-1997)	15 - 18 gpm	
Performance Standard (effluent)	1,2-DCE 1,1-DCA TCE PCE 1,1,1-TCA VC PCBs	7 µg/L 20 µg/L 5 µg/L 100 µg/L 200 µg/L 2 µg/L 1 µg/L
Remedial Goals (aquifer)	1,2-DCE 1,1-DCA TCE PCE 1,1,1-TCA VC PCBs	5 µg/L 5 µg/L 5 µg/L 100 µg/L 200 µg/L 2 µg/L .5 µg/L

Source: [4], [7]

Timeline

Table 3 shows a timeline for this remedial project.

Table 3: Project Timeline

Start Date	End Date	Activity
3/88	---	Record of Decision signed for this site
1/89	10/90	Remedial system designed
10/91	4/92	Treatment unit constructed
4/92	8/93	Treatment system operated while full system construction completed
12/92	6/93	Collection system constructed
9/93	---	Operations and quarterly monitoring began
6/94	12/94	Remedial system shutdown while contractor was replaced

Source: [5]

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards [4]

The goal of this remedy is to restore the groundwater to the primary drinking water standards as listed in Table 2. These standards are applied throughout the aquifer as measured in all on-site wells.

Treatment Performance Goals [4]

- The treatment system must reduce contaminant levels in the treated water to meet discharge requirements imposed by the local POTW. These requirements are stipulated in an industrial pretreatment permit which reflects the treatment standards included in the ROD and also are presented in Table 2.

Performance Data Assessment [5,8,9]

For this discussion and Figures 3 through 6, total contaminants consist of PCBs and VOCs.

- Figures 3 and 4 present groundwater monitoring results for the deep and shallow aquifers. Available data (through March 1996 for the deep aquifer and through May 1997 for the shallow aquifer) indicate that total contaminant concentrations have not been reduced below cleanup goals.

- Figure 3 illustrates changes in average total contaminant concentrations in the deep aquifer over time. This figure is generated from a geometric mean of data from four wells in the deep aquifer. The concentration of total contaminants was 6 µg/L in March 1996 [5,8].

- The maximum concentration of contaminants detected in the groundwater after 45 months of system operation were, PCB (BQL), TCE (530 µg/L), 1,1,1-TCA (1,700 µg/L), 1,1-DCE (1,800 µg/L), and VC (180 µg/L).

- The average groundwater concentration of total contaminants in the deep aquifer peaked at 125 µg/L in April 1993 and dropped to less than 40 µg/L by June 1993, as shown in Figure 3. The early peak appears to be due to high concentrations within one well.

- The majority of contaminants at this site are found in the shallow aquifer. Figure 4 shows an average of total contaminant concentrations detected at five manhole sampling points in the shallow aquifer. These sampling points are located in the collection trenches which intercept the shallow aquifer. MH1E located near the old LEU buildings shows the highest peak concentrations of total contaminants 1993-1997 with concentrations up to 11,800 µg/L. MH3S, located adjacent to MH1E, consistently showed the lowest measured total contaminant concentration with no discernable spiking.

- No contaminants have been detected in downgradient monitoring wells since the beginning of remedial operations. On the basis of this information, plume containment appears to have been achieved; however, containment was not a specific goal of the remedial system.

- Water level measurements indicate that the southern capture zone boundary, in the vicinity of monitoring well G111, is uncertain. A 60-inch leaking storm sewer pipe runs through the site at this point and creates an artificial recharge zone to the shallow aquifer. As a result a groundwater mound has been created which varies in size depending on precipitation and recharge rates [5].

- At wells G103, G107, and G112A, contaminant concentrations increase during wet seasons and decrease during dry seasons. This variance is likely due to

TREATMENT SYSTEM PERFORMANCE (CONT.)

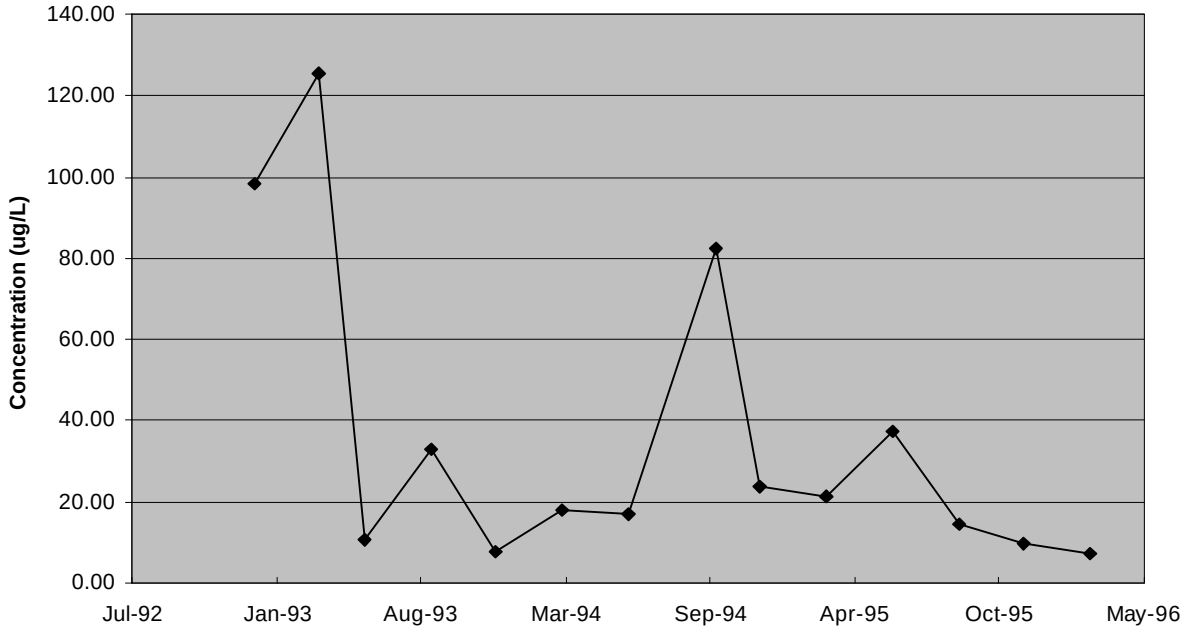

Figure 3. Average Deep Groundwater Concentrations for Total Contaminants (PCBs and VOCs) (Dec. 1992 - Mar. 1996) [6,8]

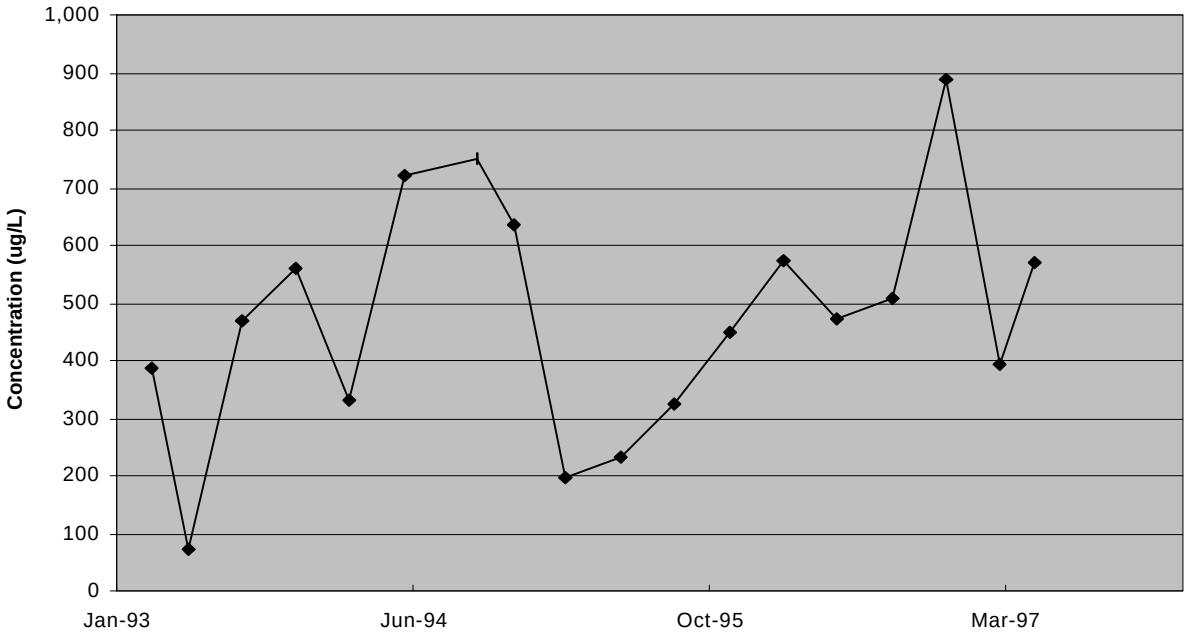

Figure 4. Total Contaminant Concentration in Shallow Aquifer Manholes (1993-1997) [6,8]

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Assessment (Cont.)

precipitation infiltrating through residual contaminated soils [5]. The concentrations detected in the collection trenches do not coincide with this pattern.

- A total of 23 million gallons of groundwater have been treated through the remedial system. Taking into account the hours of system operation, a daily average treatment rate of 15-18 gpm has been achieved.
- As shown in Figure 5, the system has removed approximately 127 pounds of contaminant mass from 1993 to September 1997.
- The mass flux rate, as shown in Figure 5, varies between 0.07 and 0.29 lbs/day from start up through July 1994 when the system was temporarily shutdown. During the later operating period from 1995 to September 1997, the mass flux rate starts at 0.02 and increases to 0.19 lbs/day.
- Based on available data, 1,1,1-TCA is the primary contaminant detected in the influent samples and makes up the majority of the mass removed by the treatment system. Figure 6 illustrates the relationship between 1,1,1-TCA and the total contaminants removed from 1993 to September 1997.

Performance Data Completeness

- Contaminant mass removal was determined using analytical results from system influent measurements, along with treatment rate data. Wells were sampled quarterly for contaminant concentrations. Influent data were available through September 1997.
- Groundwater data are available from before treatment and during quarterly sampling events. Groundwater data from January 1993 through May 1997 were used in this report. Figure 3 includes only data through March 1996 because different wells were sampled after that date.
- Figures 3 and 4 are generated by calculating a geometric mean of data from specific monitoring points. The mean is used to represent a trend across the site.
- Data are available for water level measurements from before treatment and during quarterly sampling events.
- Effluent samples are collected on a weekly basis and analyzed for PCBs and VOCs. Effluent data are available from October 1993 through September 1997.
- Monthly influent and effluent samples for total PCB and VOC contaminants were used for mass flux determinations presented in Figure 5. Cumulative mass removal was generated from these data and monthly flow rates.
- Monthly influent and effluent samples were used for TCA data presented in Figure 6.

Performance Data Quality

The QA/QC program used throughout the remedial action met the EPA and the State of Illinois requirements. All monitoring was performed using EPA-approved methods, and the site contact did not note any exceptions to the QA/QC protocols.

TREATMENT SYSTEM PERFORMANCE (CONT.)

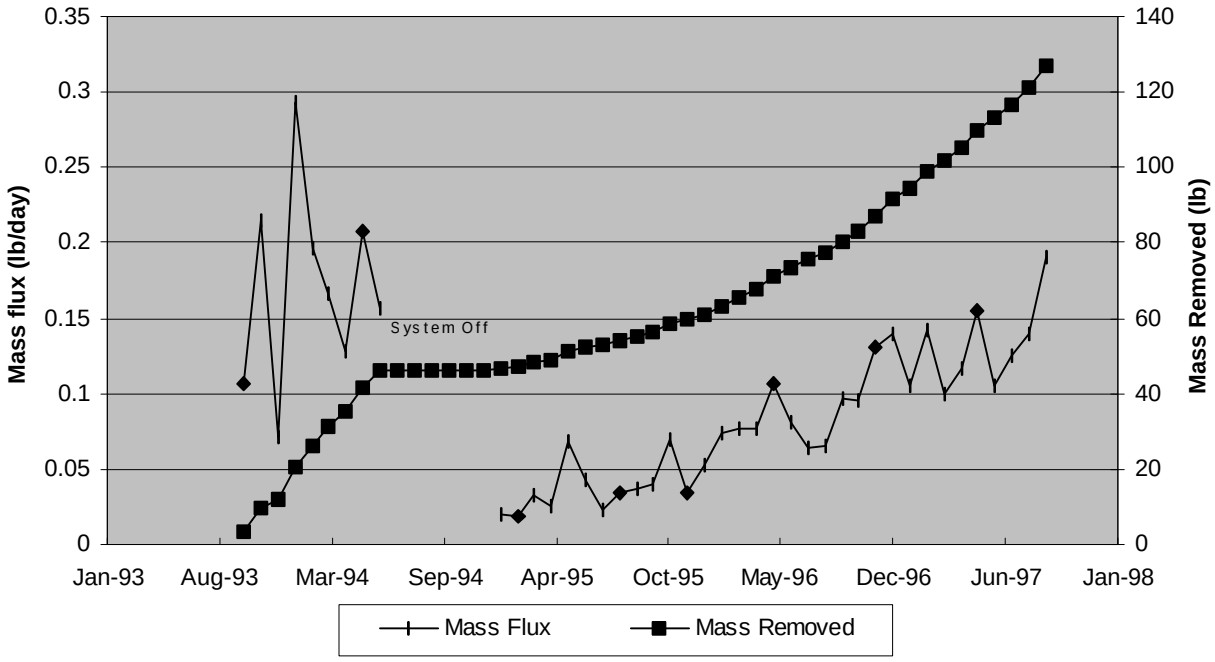

Figure 5. Mass Flux and Cumulative Removal (Oct. 1993 - Sept. 1997)

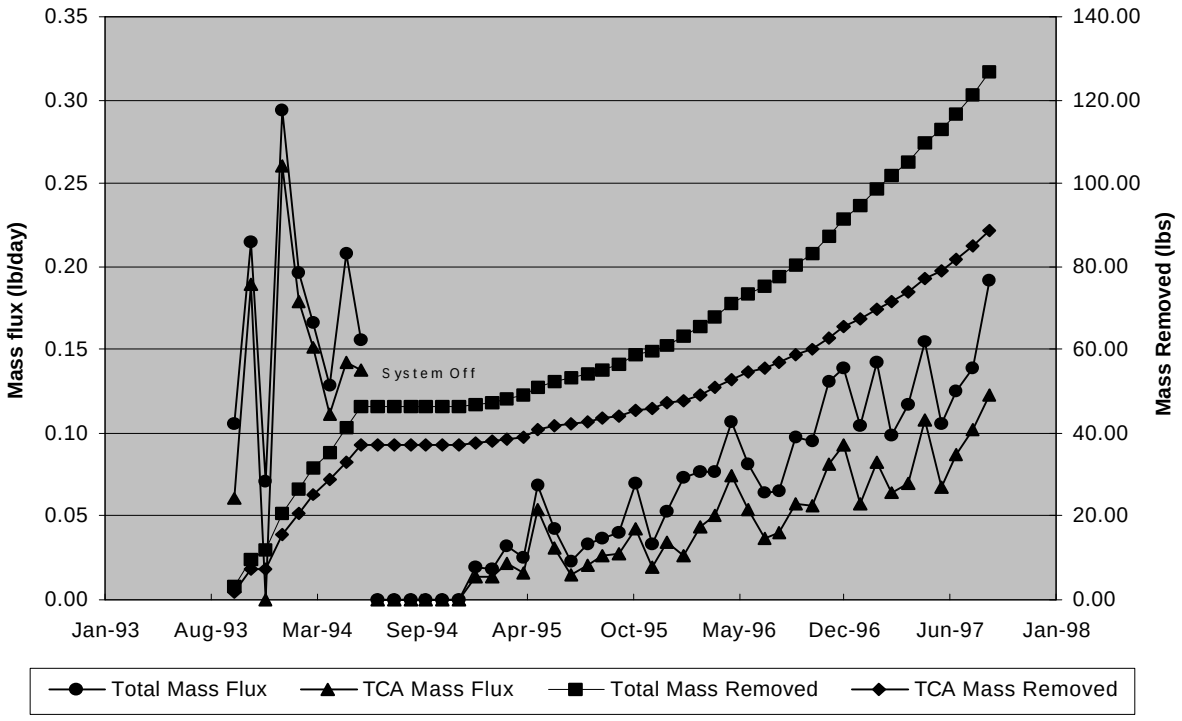

Figure 6. Comparison of TCA and Total Contaminant Mass Flux and Cumulative Removal (Oct. 1993 - Sept. 1997)

TREATMENT SYSTEM COST

Procurement Process

The IEPA is the lead agency for this site; however, U.S. EPA is providing operations and maintenance funding for the first 10 years. Ecology & Environment, Inc. has been contracted to provide site management activities. ThermoCor Kimmins was contracted to provide treatment system construction. Carmichael, Inc. has been contracted to provide long-term O&M.

Cost Analysis

- The majority of costs for design, construction, and operation of the treatment system at this site were provided by U.S. EPA.

Capital Costs [7]

Remedial Action	
Engineering and Site Management	$2,780,312
Analytical Services	$1,053,496
Parking Lot, Fence, etc.	$86,022
Treatment System	$1,186,423
Treatment Plant Structure	$208,323
Total Remedial Construction	**$5,314,576**

Operating Costs [7]

Plant Operations and Maintenance	$593,700
Analytical Services	$115,700
Carbon Treatment	$114,600
Total Cumulative Operating Expenses (1992-1997)	**$824,000**

Other Costs [7]

Remedial Design	$310,431
State Technical Assistance	$15,487
Total Remedial Design[1]	$325,918
EPA Personnel Costs	$95,895

[1]Includes the management of soils-related activities.

Cost Data Quality

Actual capital and operations and maintenance cost data are available from the IEPA for this project.

OBSERVATIONS AND LESSONS LEARNED

- Total costs for the collection and treatment system were approximately $6,138,576 ($5,314,576 in capital and $824,000 in operations and maintenance) which corresponds to $48,000 per pound of contaminants removed and $266 per 1,000 gallons of groundwater.
- The collection system was installed in phases over a six-month period. On-site excavation was only to meet the remedial action objectives for PCBs in soil as stated in the ROD. The collection underdrain system was installed post-excavation for PCB thermal treatment and prior to backfilling. This sequential installation significantly reduced re-excavation and resulting costs.
- The treatment system performance data indicate that approximately 127 pounds of contaminants were removed from the groundwater over 45 months; however, the collection and treatment system has not achieved the cleanup goal.
- The leaking storm sewer drain has caused an artificial recharge zone in the vicinity of the collection system. The storm sewer trench may also act as a conduit for plume migration off site [5].

OBSERVATIONS AND LESSONS LEARNED (CONT.)

- At specific monitoring wells, contaminant concentrations fluctuate with precipitation rates. During wet seasons contaminant concentrations are observed to increase, which is an indicator that contaminant materials are trapped in pore spaces or sorbed to unsaturated soils. When precipitation infiltrates, the contaminants are transported into the groundwater [5].

- PCBs were initially expected to be the primary contaminant at this site. According to the site contact and as shown in Figure 6, TCA accounts for the majority of the total contaminants in groundwater at the site [7].

- According to the site contact, the original design has been adequate in addressing the site cleanup efforts to date. No design alterations are currently being considered [7].

- The visual observation of an oily DNAPL material in a well casing confirms the presence of subsurface source zones. Additional subsurface source zones are likely present at this site. Persistent and highly variable concentrations in the groundwater may indicate the presence of additional DNAPLs, which may act as sources for persistent groundwater contamination.

REFERENCES

1. Phase II Construction Oversight, Ecology and Environment Engineering, April 1989.

2. Phase II Remedial Design, Ecology and Environment Engineering, June 1988.

3. Remedial Project Manager, U.S. Environmental Protection Agency.

4. Record of Decision, U.S. Environmental Protection Agency, March 1988.

5. Review and Assessment of Performance Report, LaSalle Electric Utilities Company Site, Groundwater Treatment Unit Inception Through December 1995, Ecology and Environment, Inc. 1996.

6. Phase II Remedial Investigation, Groundwater Hydrogeological Report, Ecology and Environment, Inc. 1988.

7. Conversations with IEPA Representative, May 29, 1997.

8. Quarterly monitoring data from Ecology and Environment, Inc. (1996-1997).

9. Monthly treatment unit data from LEU. (January 1996 - September 1997) Data supplied by Rich Lange, IEPA.

Analysis Preparation

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Eastern Research Group, Inc. and Tetra Tech EM Inc. under EPA Contract No. 68-W4-0004.